Control Session

State Space

* Representation
  - Controller Canonical
  - observer
  - Paraller

* Analysis
* Design

$$\dot{x} = Ax + Bu$$
$$y = Cx$$

→ **Controllability :-**

change in u → change in x (All states)

- B: non zero vector.
- Controllable Canonical

$$A = \begin{bmatrix} 0 & I \\ a_1 & a_2 \quad a_3 \end{bmatrix} \qquad B = \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix}$$

→ non zero element

observability

← معناها انى أقدر أشوف الـ (states) بتاعة الـ (system).

$$y = C X$$

→ C : non zero vector.

→ C : non zero element

$$[1 \quad 0 \quad 0 \quad 0]$$

← اما الـ (matrix A) تكون (observer Canonical form)

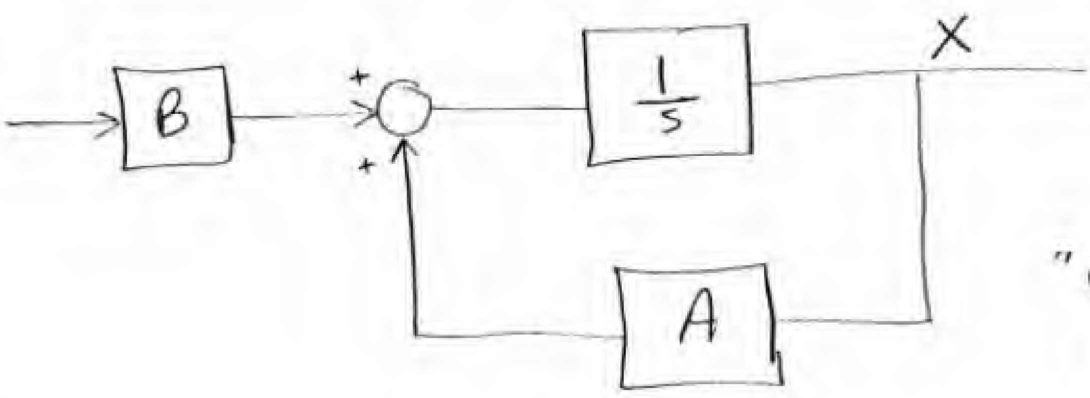
"Design"

* Desired closed loop c/c eqn

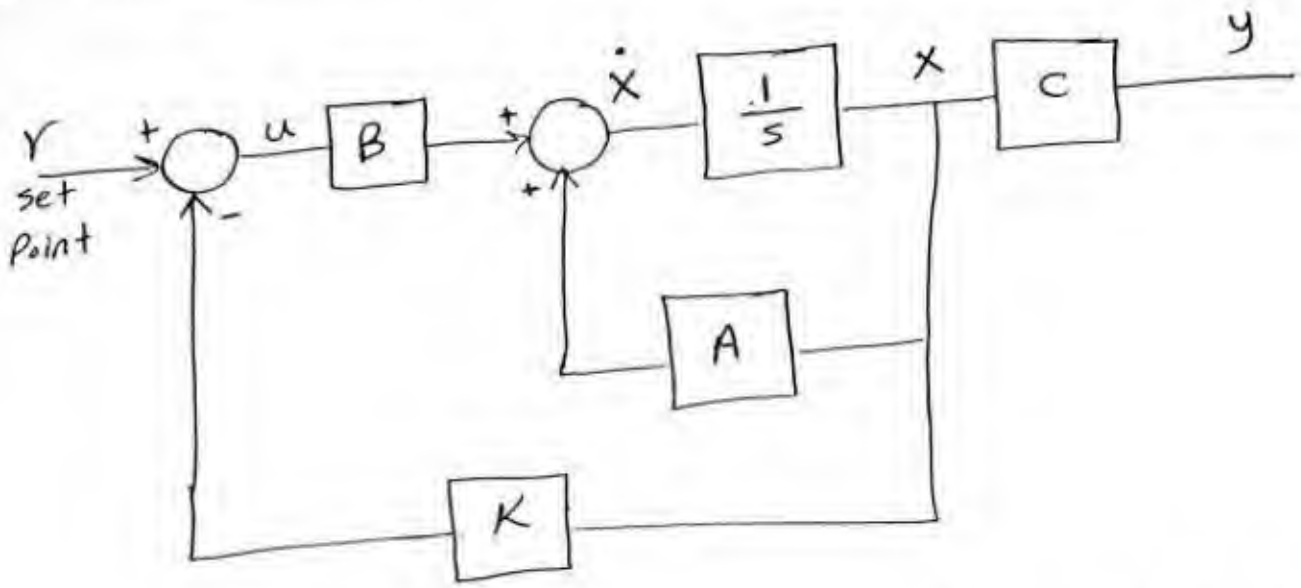
$$\alpha(s) = 0$$

In state space

$$O.L.T.F \Rightarrow |SI - A| = 0$$



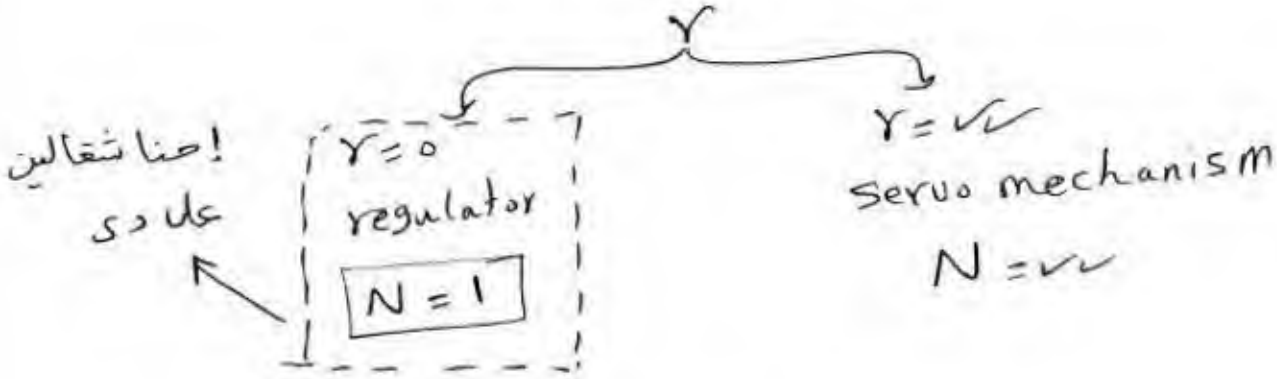
"internal feedback"



← أي (Controller)

* يظبط الـ (dynamics) بتاعة الـ (system).

* يوصلني لـ (desired gain).



C.L. system become

$$\dot{X} = AX - BKX$$

$$= (A - BK)X$$

⊗ C.L.C/C equation

$$|sI - (A-BK)| = 0$$

→ Control Target

choose K such that

$$|sI - A + BK| = \alpha_c(s)$$

[1] Coeffecient Comparison

[2] Ackarman form → $K = [0 \; 0 \; 0 \; 1] \, \mathcal{M}_c^{-1} \, \alpha_c(A)$

EX

$$\dot{X} = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ -a_1 & -a_2 & -a_3 \end{bmatrix} x + \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix} u$$

$$A-BK = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ -a_1 & -a_2 & -a_3 \end{bmatrix} - \begin{bmatrix} 0 & 0 & 0 \\ 0 & 0 & 0 \\ K_1 & K_2 & K_3 \end{bmatrix}$$

$$A-BK=\begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ -a_1-K_1 & -a_2-K_2 & -a_3-K_3 \end{bmatrix}$$

Given

$$\dot{X}=\begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ -3 & -6 & -7 \end{bmatrix} X + \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix} u$$

→ Design state feedback controller such that desired C.L c/c eqn

$$\alpha_c(s) = s^3 + 12s^2 + 47s + 60$$

sol

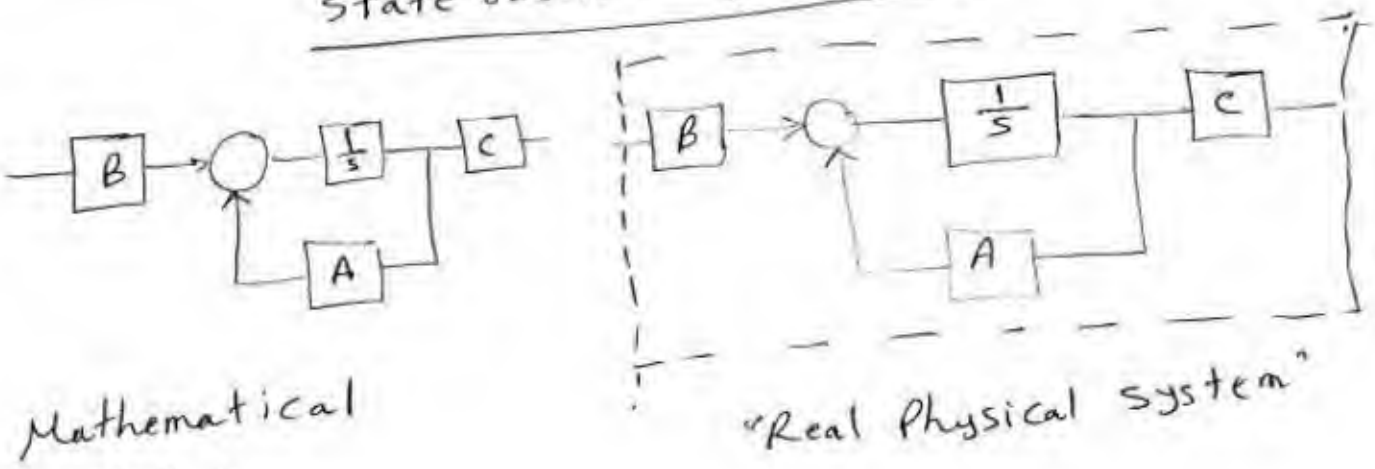
$$|sI-(A-BK)| = 0$$

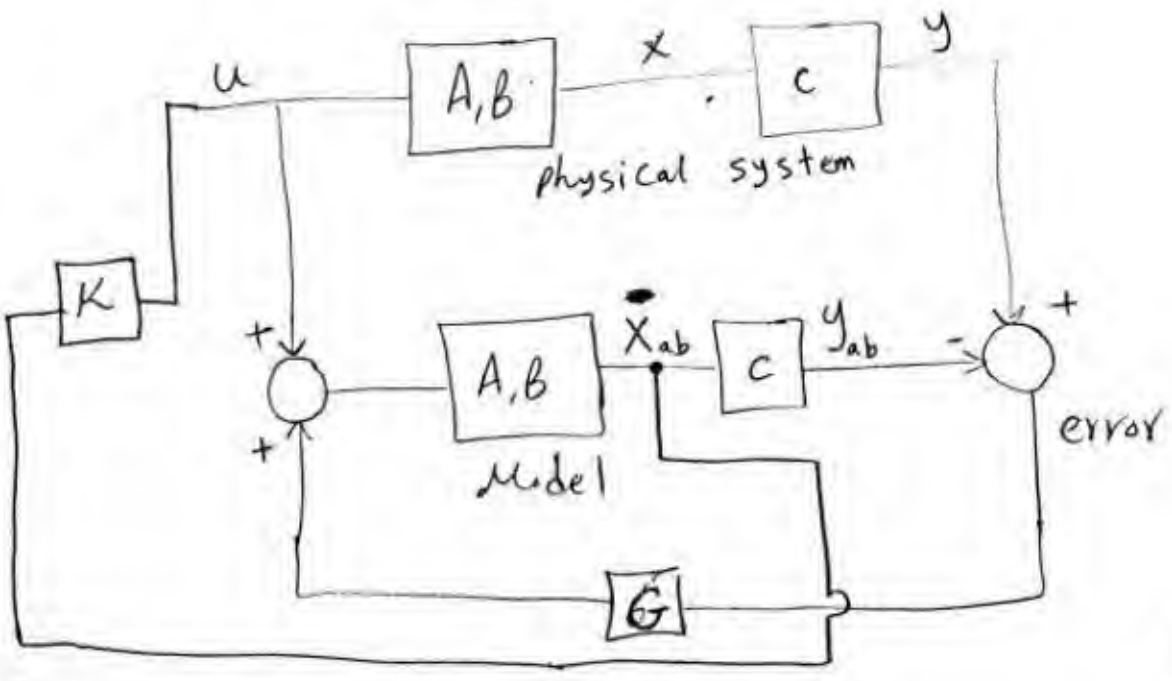
$$= \begin{bmatrix} s & 0 & 0 \\ 0 & s & 0 \\ 0 & 0 & s \end{bmatrix} - \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ -3-K_1 & -6-K_2 & -7-K_3 \end{bmatrix}$$

$$|sI-(A-BK)| = \left| \begin{bmatrix} s & -1 & 0 \\ 0 & s & -1 \\ 3+K_1 & 6+K_2 & 7+K_2 \end{bmatrix} \right|$$

$$\boxed{s^3 + (7+K_3)s^2 + (6+K_2)s + (3+K_1) = 0}$$

state observers (estimation)





بالنسبة لـ G ← هنفضل أعطي (Actions) حتى يصل الـ (error) لصفر.
$(y - y_{ab})$.

هاخد (feedback) من الـ (model) عشان أتحكم عليه الـ (Controller) بتاعي (الـ feedback الخارج من K)

← الـ (observer) لازم يكون أسرع من الـ (system) نفسه لأن الـ (system) بيحتاج قرار معين على أساسه يقوم بعمل (action) معين فالـ (observer) بيكون متواجد من أجل ذلك.

الجزء القادم معلومات عامة

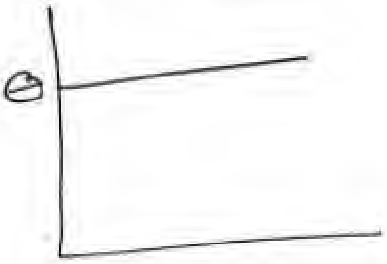
$$G = \alpha_0(A)\, \mathcal{K}_0^{-1} \begin{bmatrix} 0 \\ 0 \\ 0 \\ 1 \end{bmatrix}$$

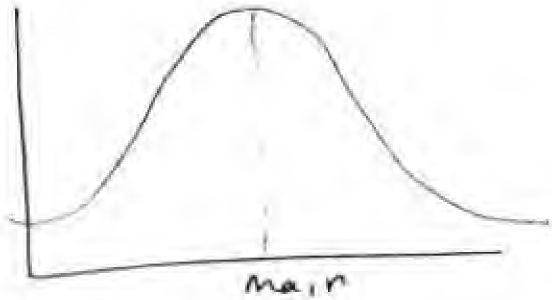
← هل لما أعمل (estimation) للـ system يكون الـ (model) الناتج صحيح ؟؟ لأطبعاً هيبقى فيه نسبة error.

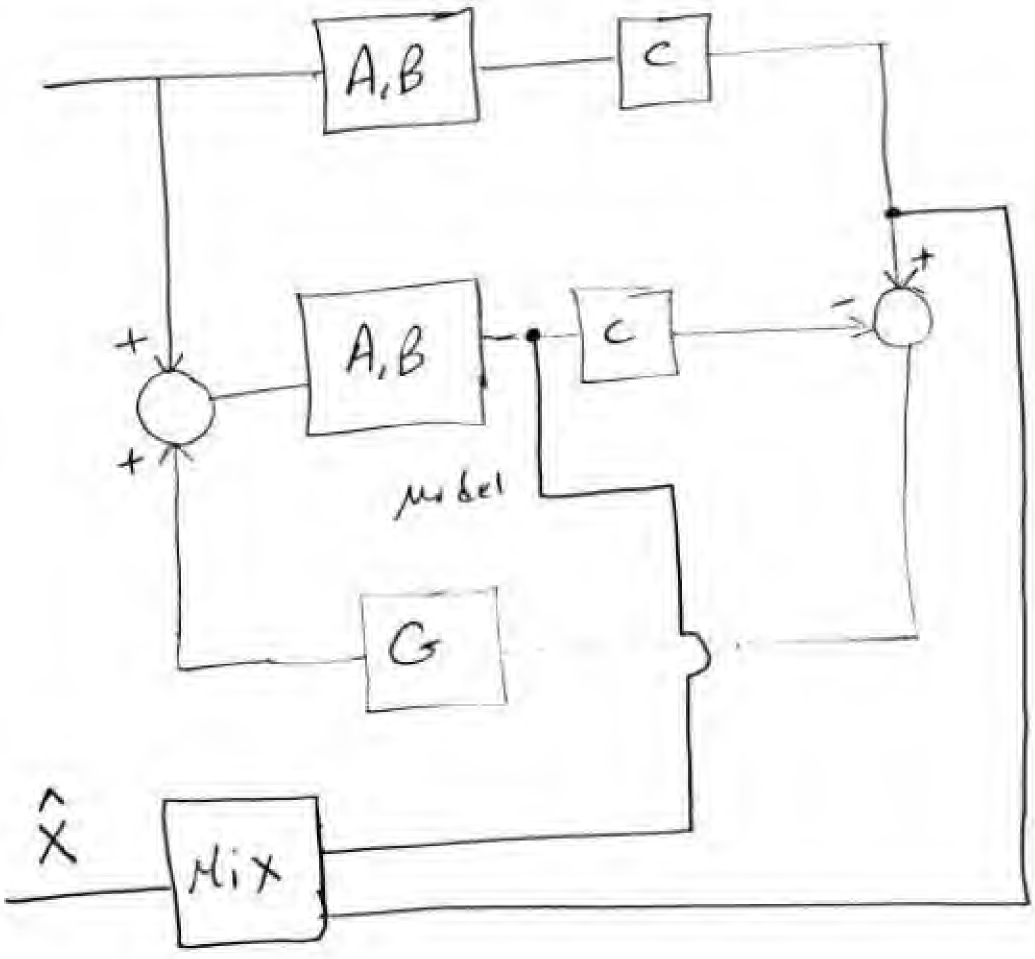
1 Model uncertainity (stochastic form)
← يضيف الـ (system) على أساس الـ (uncertainty)

2 sensor noise (stochastic form)

stochastic form







← ال (model) هو (software)
يعني (digital).